Complete Summary

GUIDELINE TITLE

Hematuria—child.

BIBLIOGRAPHIC SOURCE(S)

Coley BD, Gunderman R, Blatt ER, Fordham L, Podberesky DJ, Prince JS, Expert Panel on Pediatric Imaging. Hematuria - child. [online publication]. Reston (VA): American College of Radiology (ACR); 2006. 6 p. [39 references]

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Royal SA, Slovis TL, Kushner DC, Babcock DS, Cohen HL, Gelfand MJ, Hernandez RJ, McAlister WH, Parker BR, Smith WL, Strain JD, Strife JL, Joseph D. Hematuria. American College of Radiology. ACR Appropriateness Criteria. Radiology 2000 Jun;215(Suppl):841-6.

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

COMPLETE SUMMARY CONTENT

SCOPE

DISEASE/CONDITION(S)

Hematuria

GUIDELINE CATEGORY

Diagnosis
Evaluation

CLINICAL SPECIALTY

Family Practice
Pediatrics
Radiology
Urology

INTENDED USERS

Health Plans
Hospitals
Managed Care Organizations
Physicians
Utilization Management

GUIDELINE OBJECTIVE(S)

To evaluate the appropriateness of initial radiologic examinations for pediatric patients with hematuria

TARGET POPULATION

Pediatric patients with hematuria

INTERVENTIONS AND PRACTICES CONSIDERED

1. Ultrasound (US), kidney and bladder
2. X-ray
    - Abdomen and pelvis
    - Intravenous pyelography (IVP)
    - Retrograde urography
3. Computed tomography (CT), abdomen and pelvis, with and without contrast
4. Magnetic resonance imaging (MRI), abdomen and pelvis
5. Invasive (INV)
    - Voiding cystourethrography (VCUG)
    - Angiography

MAJOR OUTCOMES CONSIDERED

Utility of radiologic examinations in differential diagnosis

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

The guideline developer performed literature searches of peer-reviewed medical journals and the major applicable articles were identified and collected.

NUMBER OF SOURCE DOCUMENTS

The total number of source documents identified as the result of the literature search is not known.

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Not Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Not stated

METHODS USED TO ANALYZE THE EVIDENCE

Systematic Review with Evidence Tables

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

One or two topic leaders within a panel assume the responsibility of developing an evidence table for each clinical condition, based on analysis of the current literature. These tables serve as a basis for developing a narrative specific to each clinical condition.

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus (Delphi)

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

Since data available from existing scientific studies are usually insufficient for meta-analysis, broad-based consensus techniques are needed for reaching agreement in the formulation of the appropriateness criteria. The American College of Radiology (ACR) Appropriateness Criteria panels use a modified Delphi technique to arrive at consensus. Serial surveys are conducted by distributing questionnaires to consolidate expert opinions within each panel. These questionnaires are distributed to the participants along with the evidence table and narrative as developed by the topic leader(s). Questionnaires are completed by participants in their own professional setting without influence of the other members. Voting is conducted using a scoring system from 1-9, indicating the least to the most appropriate imaging examination or therapeutic procedure. The survey results are collected, tabulated in anonymous fashion, and redistributed after each round. A maximum of three rounds is conducted and opinions are unified to the highest degree possible. Eighty percent agreement is considered a

consensus. This modified Delphi technique enables individual, unbiased expression, is economical, easy to understand, and relatively simple to conduct.

If consensus cannot be reached by the Delphi technique, the panel is convened and group consensus techniques are utilized. The strengths and weaknesses of each test or procedure are discussed and consensus reached whenever possible. If "No consensus" appears in the rating column, reasons for this decision are added to the comment sections.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

Internal Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

ACR Appropriateness Criteria®

Clinical Condition: Hematuria – Child

Variant 1: Isolated hematuria.

Radiologic Procedure	Appropriateness Rating	Comments
US, kidney and bladder	7	
X-ray, abdomen and pelvis	2	
INV, VCUG	2	
X-ray, intravenous pyelography (IVP)	2	

Radiologic Procedure	Appropriateness Rating	Comments
CT, abdomen and pelvis	2	
MRI, abdomen and pelvis	2	
INV, angiography	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Painful hematuria (non-traumatic).

Radiologic Procedure	Appropriateness Rating	Comments
CT, abdomen and pelvis, with contrast	8	Without contrast to evaluate for stones
US, kidney and bladder	7	
X-ray, abdomen and pelvis	6	
X-ray, intravenous pyelography (IVP)	2	
INV, VCUG	2	
MRI, abdomen and pelvis	2	
INV, angiography	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Traumatic hematuria – macroscopic.

Radiologic Procedure	Appropriateness Rating	Comments
CT, abdomen and pelvis, with contrast	9	
X-ray, retrograde urography	6	If blood present at urethral meatus.
X-ray, abdomen and pelvis	2	
US, kidney and bladder	2	
X-ray, intravenous pyelography (IVP)	2	
MRI, abdomen and pelvis	2	
INV, angiography	2	May be appropriate for interventional therapy.
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: Traumatic hematuria – microscopic.

Radiologic Procedure	Appropriateness Rating	Comments
CT, abdomen and pelvis, with contrast	6	CT may be indicated in the presence of risk factors such as pelvic fractures, flank pain and tenderness, hypotension, or other injuries.
US, kidney and bladder	4	US can exclude mass or anomaly.
X-ray, abdomen and pelvis	2	
INV, VCUG	2	
X-ray, intravenous pyelography (IVP)	2	
MRI, abdomen and	2	

Radiologic Procedure	Appropriateness Rating	Comments
pelvis		
INV, angiography	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

Hematuria is the presence of red blood cells in the urine, either visible or as viewed under the microscope. Detecting blood in the urine of a child causes great alarm to patients, parents, and physicians.

The clinical evaluation of children with any form of hematuria begins with a meticulous history. Topics covered in the history should include urinary tract infection, strenuous exertion, tropical exposure, recent strep throat, and recent trauma, menstruation, bleeding tendency, bloody diarrhea, joint pains, rash, flank pain, frequency and dysuria. Searching for occult forms of trauma, foreign body insertion, family history of sickle cell disease or hemophilia, stone disease, hearing loss, and familial renal disease, hematuria, and hypertension should be undertaken. Factitious causes of "hematuria", such as food substances or medicines coloring the urine without actually having red blood cells in the urine, should also be investigated. An assessment of the child's height and weight should be followed by a thorough physical examination. Fevers, arthritis, rashes, edema, nephromegaly, abdominal masses, genital or anal bleeding suggesting sexual abuse, deafness, and costovertebral angle tenderness should be discerned.

The next step is a thorough evaluation of the urine. Tea-colored urine and hematuria accompanied by proteinuria (>2+ by dip stick), red blood cell casts, and deformed red blood cells (best seen with phase contrast microscopy) suggest a glomerular source of hematuria (i.e., glomerulonephritis). As will be discussed, imaging is seldom required for glomerular sources of bleeding, whereas it may be useful in nonglomerular sources of hematuria. White cells and organisms clearly indicate the possibility of a urinary tract infection, which will direct care and imaging by a different set of criteria. Evaluation for hypercalciuria (such as a spot urine calcium/creatinine ratio) and a urine culture may be indicated. Basic laboratory metabolic screening will indicate findings of chronic renal insufficiency or long standing acidosis; initial evaluation should include a blood urea nitrogen (BUN), creatinine, complete blood count, and a platelet count. If suggested by the initial clinical workup, more advanced medical assessment for various causes of glomerulonephritis and vasculitis should be performed, and an audiogram should be performed if indicated.

The need for imaging evaluation depends on the clinical scenario in which hematuria presents. This review focuses on the following clinical variations of childhood hematuria:

1. Isolated hematuria
2. Painful hematuria
3. Renal trauma with gross hematuria
4. Renal trauma with microscopic hematuria

The literature on pediatric hematuria generally consists of cohort studies (most being retrospective), as well as literature reviews and reports of personal experience. There are no randomized controlled trials or comparison studies with control groups. Despite these potential limitations, however, there are good and reasonably consistent data in the more recent literature to provide guidance on whether and how to image children with hematuria.

Isolated Hematuria

When the child has a definite medical diagnosis suggested by clinical evaluation (such as postinfectious glomerulonephritis, Henoch-Schönlein purpura, coagulopathy, sickle cell disease, systemic lupus erythematosus, or infection), imaging may be necessary to assess the size of the kidneys as an indicator of the chronicity of the renal disease and also as a potential assessment before renal biopsy. In this situation, ultrasound (US) is the best modality to display the anatomy, size, and position of the kidneys (especially prior to biopsy), and to screen for other pre-existing structural lesions in a patient with glomerulonephritis. If the US findings are normal, renal biopsy can sometimes add to the diagnosis of the common renal parenchymal diseases causing hematuria, such as immunoglobulin A (IgA) nephropathy (Burger's disease) or Alport's syndrome. However, many patients are followed clinically at this point without more extensive workup.

While isolated asymptomatic gross hematuria may have benign and self-limited processes (such as viral cystitis), there is fair to good evidence to perform US on these patients. Renal and bladder tumors may present with gross hematuria and are likely to be found with US. Since the incidence of transitional cell uroepithelial neoplasia is extremely rare in children, intravenous pyelography (IVP) is not indicated. While computed tomography (CT) is an excellent modality for imaging the genitourinary tract, given its expense and radiation exposure it is probably not indicated as a first line test. In the cases of a suspected vascular lesion, such as a distended left renal vein from the nutcracker phenomenon or an intrarenal vascular malformation, US is still the best method of initial evaluation, although contrast-enhanced CT and even angiography may be necessary for further diagnosis.

Asymptomatic microscopic hematuria (usually defined as five or more red blood cells per high-powered field on at least two of three consecutive urine specimens) is a common entity, with an incidence estimated to be 0.25% to 1.0% in children 6 to 15 years of age. Patients without proteinuria or dysmorphic red blood cells (which indicate glomerular disease) are unlikely to have clinically significant renal disease, and there is good evidence that no imaging is indicated. One study evaluated 325 patients with microscopic hematuria; 87% had renal US and 24%

had voiding cystoscopy urethrograms (VCUGs), and no findings were deemed to be clinically significant. As with isolated gross hematuria, IVP is not indicated in evaluating microscopic hematuria. Microscopic hematuria is sometimes associated with hypercalciuria and/or hyperuricosuria, and some authors advocate renal US to evaluate for renal calculi in these patients, although others have found little value. In cases of persistent unexplained microhematuria, US may be useful to evaluate for occult anatomic abnormalities (cystic renal disease, vascular abnormalities, congenital malformations, etc), although the yield of these examinations is likely low. When nonmedical pressures (such as parental anxiety over neoplasia) are an issue, US is the modality of choice due to its relatively lower cost and lack of patient risk, and in some cases it may be justified for the reassurance it provides. However, it must be recognized that isolated microscopic hematuria is almost never the presenting scenario of Wilms tumor.

If no diagnosis has been made and further workup is deemed necessary, evaluation of children is different than in adults. Cystoscopy is rarely indicated in the workup of a child with hematuria, whereas adults would routinely have cystoscopy performed to evaluate for transitional cell carcinoma of the bladder. Examination of the urinary bladder in the child will be performed during the renal US to assess for the presence of bladder lesions not diagnosed by the medical workup, such as polyps, masses, or vascular lesions of the bladder. A VCUG should be considered to evaluate for vesicoureteral reflux, posterior urethral valves in the male, or other urethral causes of hematuria such as meatal stenosis, Cowper's duct cyst, urethral stenosis, or an abnormality of the fossa navicularis. A renal or bladder mass that is detected by US should have further imaging with CT or magnetic resonance imaging (MRI) to define extent of disease, vascular invasion (in the case of Wilms tumor), and presence of metastases.

Painful Hematuria

In the patient with abdominal pain and hematuria, the principal differential diagnosis is urolithiasis, although tumor and ureteropelvic junction (UPJ) obstruction should also be included. In young patients with genitourinary tract stone disease, the presenting symptoms may not be as classic as in adults, which in turn leads to uncertainty about the best imaging approach. Pediatric stone disease has an incidence less than 2% of that in adults but is still commonly seen in busy pediatric practices. While the literature provides some general suggestions and guidelines, what imaging test to perform under what clinical scenario is not universally agreed upon.

There **is** good evidence in the adult and pediatric imaging literature that CT is the most accurate imaging modality in the identification of stones and the quantification of stone burden. CT scanning of course exposes these children to ionizing radiation. While with proper techniques the CT dose can be lowered to that less than a traditional IVP, it raises the question of whether other imaging modalities (specifically plain radiographs and US) still play a role in pediatric stone disease. In a study of 178 adult and pediatric patients, it was found that plain radiographs had a 59% sensitivity for stone detection. Another study reported that US found 75% of all urinary tract stones, although US found only 38% of stones within the ureter. Similarly, a third study showed that US correctly found stones in 78% of patients, although it only found 25% of urethral stones. Limitations of both plain radiography and US in children include greater

obscuration by bowel gas and contents, and smaller stone size than in adults, neither of which impairs CT evaluation.

The evidence is very good for the use of CT to detect genitourinary tract stones in children. However, given the often vague nature of symptoms in pediatric nephrolithiasis, there is fair evidence that plain radiographs may still have some use especially in a patient with a personal or family history of stone disease. Similarly, US is still recommended as an initial screening test, and if positive can then direct patient management, with the caveat that a negative US does not exclude stone disease. In this approach, dose-adjusted CT is reserved for problematic cases. However, a reasonable argument can be made for limited dose-adjusted CT as the initial study of choice (especially in patients without a prior history of stones); it has the advantage of providing information about other pathology. IVP is seldom indicated in children as an initial examination, although a limited study may provide information about stone position and movement after initial diagnosis.

Traumatic Hematuria

Hematuria is frequently found in the pediatric patient with blunt abdominal trauma. In children, the most commonly injured viscera are the spleen, liver, and kidney. The amount of hematuria that should trigger radiologic investigation of the urinary tract is somewhat controversial, but several facts are well accepted:

1. Gross hematuria is a finding that necessitates a radiologic evaluation of the abdomen and pelvis.
2. Isolated microscopic hematuria without any clinical or laboratory findings of visceral trauma does not need emergency investigation.
3. The presence of blood in the urethral meatus in a patient with pelvic fractures should lead to an investigation of the urethra and bladder (50% incidence of genitourinary injury).
4. Minor trauma to an anomalous kidney can cause major clinical repercussions (renal anomalies occur in 1% to 4% of the population).
5. All CT scans must be done with IV contrast (enhanced CT).
6. Hypotension is an unreliable clinical indicator for prompting imaging in children

Macroscopic Hematuria

There is good evidence from multiple adult and pediatric studies that contrast-enhanced CT scan is the best modality for evaluating renal trauma, and that such imaging is required in patients with gross hematuria. While US has been advocated as a first line imaging test in abdominal trauma, renal injuries are sometimes missed, and in the setting of gross hematuria these patients are better served with CT. If renal injury is detected on CT, then obtaining delayed scans to evaluate for collecting system disruption should be considered.

Patients with gross hematuria and pelvic fractures are at high risk for bladder rupture. The conventional fluoroscopic cystogram requires moving the patient to another imaging suite. There is good evidence that CT cystography is an accurate method of evaluation, with the advantage that the patient need not be moved from the CT scanner. In general, images are obtained with a contrast-filled

bladder and then after drainage, although one study in adults suggests that postvoid images may be unnecessary.

Patients with blood at the urethral meatus, especially if associated with pelvic fractures or straddle injuries, are at risk for urethral injury and disruption. These patents should undergo retrograde urography (RUG) prior to bladder catheter placement and may warrant a cystogram to exclude concomitant bladder injury.

The limited or "one-shot" IVP was once a mainstay of adult renal trauma imaging. In current practice in a hemodynamically stable pediatric patient, the IVP has little role in the evaluation of hematuria.

Microscopic Hematuria

Different threshold values have been used for evaluating post-traumatic microhematuria, but in general >50 red blood cells per high-powered field (RBC/hpf) has been used as a threshold for imaging. However, recent studies note at best a fair correlation between degree of microhematuria and risk or severity of renal injury, and the use of a cutoff value may not be appropriate.

For patients with isolated microscopic hematuria without coexistent injury, there is good evidence that renal imaging with CT is unlikely to disclose clinically significant findings. While there have been advocates for US in this setting, it is unlikely to provide meaningful patient management information.

However, children with microhematuria can have significant renal trauma, almost always associated with coexistent injury or congenital abnormalities, and associated clinical findings. There is good evidence that patients with multi-organ injury, a history of deceleration injury, localized flank pain, and ecchymosis should undergo CT imaging to evaluate for renal injury. While hypotension is an unreliable clinical indicator in the child (unlike the adult), a child with a falling hemoglobin or hemodynamic instability should be considered for imaging.

Abbreviations

- CT, computed tomography
- INV, invasive
- MRI, magnetic resonance imaging
- US, ultrasound
- VCUG, voiding cystourethrography

CLINICAL ALGORITHM(S)

Algorithms were not developed from criteria guidelines.

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The recommendations are based on analysis of the current literature and expert panel consensus.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Selection of appropriate radiologic imaging procedures for evaluation of pediatric patients with hematuria

POTENTIAL HARMS

Computed tomography exposes children to ionizing radiation.

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

An American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

IMPLEMENTATION TOOLS

Personal Digital Assistant (PDA) Downloads

For information about availability, see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better

IOM DOMAIN

Effectiveness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

Coley BD, Gunderman R, Blatt ER, Fordham L, Podberesky DJ, Prince JS, Expert Panel on Pediatric Imaging. Hematuria - child. [online publication]. Reston (VA): American College of Radiology (ACR); 2006. 6 p. [39 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

1999 (revised 2006)

GUIDELINE DEVELOPER(S)

American College of Radiology - Medical Specialty Society

SOURCE(S) OF FUNDING

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

GUIDELINE COMMITTEE

Committee on Appropriateness Criteria, Expert Panel on Pediatric Imaging

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

Panel Members: Brian D. Coley, MD; Richard Gunderman, MD, PhD; Ellen R. Blatt, MD; Lynn Fordham, MD; Daniel J. Podberesky, MD; Jeffrey Scott Prince, MD

FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Royal SA, Slovis TL, Kushner DC, Babcock DS, Cohen HL, Gelfand MJ, Hernandez RJ, McAlister WH, Parker BR, Smith WL, Strain JD, Strife JL, Joseph D. Hematuria. American College of Radiology. ACR Appropriateness Criteria. Radiology 2000 Jun;215(Suppl):841-6.

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

GUIDELINE AVAILABILITY

Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.

ACR Appropriateness Criteria® *Anytime*, *Anywhere*™ (PDA application). Available from the ACR Web site.

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

AVAILABILITY OF COMPANION DOCUMENTS

The following is available:

- ACR Appropriateness Criteria®. Background and development. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.

PATIENT RESOURCES

None available

NGC STATUS

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Date Modified: 11/3/2008